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Solar Energy Resources And Their Rate Of Development

Abdullaev Elnur

Faculty of Power engineering and Radio electronics
Jizzakh polytechnic institute, Jizzakh city, Uzbekistan
Uchqun8822@gmail.com

Abstract — *Today, the need for energy sources is higher than ever. This is especially true in the context of the depletion of oil and gas resources. The use of solar energy as a solution to this problem is being considered. This paper provides information on the use of solar energy.*

Keywords — solar energy, solar installations, Photovoltaic power plants, Thermodynamic solar power plants.

Introduction

The annual amount of solar energy perceived by the planet Earth is thousands of times greater than the reserves of all its fossil energy resources. So far, this fact is hardly acceptable to the energy sector. The solar energy flux reaching the upper boundary of the Earth's atmosphere is $5.6 \cdot 10^{15}$ MJ / year. The Earth's atmosphere reflects 35% of this energy back into space, and the rest of the energy goes to heating the soil, air, the formation of air and sea currents, the evaporation of water, etc. zones and much more. Therefore, the widespread use of solar radiation for energy purposes would lead to an environmental disaster. The average annual amount of solar energy supplied per day per 1 m^2 of the earth's surface ranges from 7.2 MJ / m^2 in the northern countries to 21 MJ / m^2 in the desert zone. So, if we take the efficiency of converting solar energy into electrical energy at the level of 10%, then the energy from 1% of the desert surface (this is 200 thousand km2) will be enough to cover modern electricity needs.

Materials and methods

Humanity has been using solar energy since time immemorial, however, this experience has not received such a significant distribution as windmills or water wheels, and therefore little known. Back in the 3rd century BC. solar mirrors were used to light sacred fires in temples. In 1600, the first heated air engine was created in France. A. Lavoisier built a solar furnace with a temperature of 1650 $^{\circ}$C, in which he studied the properties of carbon and platinum. In the 60s of the XIX century, the Frenchman A. Musho built several solar concentrators in Algeria, which were used to obtain fresh water. He also demonstrated a solar cooking oven at the World's Fair in Paris in 1878. In 1890, in Moscow, Professor V.K. Tsesarsky, focusing solar energy with a parabolic mirror, obtained a temperature of 3000 $^{\circ}$C in an installation for melting metals.

Currently, there are two directions for the use of solar energy related to energy.

The first direction is heat production, primarily for hot water supply, as well as for heating. The total number of such plants reaches 5 million, and more than half of them are low-capacity plants (less than 500 liters per day) for individual consumers. Solar heating is most widespread in a number of southern countries (USA, Japan, France, South Africa, Australia, Israel, Cyprus, etc.). For example, in Cyprus more than 80% of private houses are equipped with such installations. More powerful units (usually in combination with traditional methods of heating water) are used in centralized hot water supply systems in residential and public buildings, reducing by 40 - 80% energy costs for hot water supply, heating, air conditioning. According to Bezrukikh's data, the total thermal capacity of installations for the production of heat from solar radiation in 2000 was 13,000 MW and by 2010 it will reach 55,000 MW. Of course, these figures are very rough. It should be noted that solar heating in combination with traditional types of heating is successfully used in northern countries, for example, in Sweden and Norway.

The second direction is associated with obtaining electricity from the sun, or, as is often said, photoelectricity. The production of commercial electrical energy (i.e. equivalent to the one present in the electrical network) is still underdeveloped due to its high cost. However, solar sources of non-commercial electricity (usually with a capacity of less than 1 kW) have been widely developed in the field of powering radio electronic equipment, computers, and navigation devices. There are also larger objects, such as highway lights and billboards. In general, the proponents of photovoltaics are largeconsider power plants with a capacity of more than 100 kW, which may cause some bewilderment among power engineers.

Discussion

To this day, the cost of photovoltaics is 10 to 20 times higher than the commercial cost of energy purchased from a conventional electricity grid. However, this cost decreases from year to year. If this trend continues, then we can expect that in 10 - 20 years photoelectricity will become a reality for real power engineering. First of all, this will happen where the main factor is not cost, but, for example, comfort. In a number of countries, such as the United States, photovoltaics are widely used as a power source for computers, ensuring their complete independence from power outages.

Table 1

World photovoltaic market, MW

Market Segment Years	Years			
	1990	2000	2008	2018
Consumer goods	16	22	30	40
Communication and communication	14	23	31	40
Units connected to the network	1	7	36	110
Other power plants	17	47	56	65
Total	48	89	153	255

Table 1 shows the dynamics of changes in the global photovoltaic market.

Classification and schemes. In the literature, one can find a description of various classifications and modifications of solar water heating installations, sometimes they are called solar installations (from the Greek helios - the Sun). According to the method of circulation of the coolant, solar water heating installations are divided into two types: with natural and forced circulation, according to the method of transferring the body - into single-circuit and double-circuit. It is also possible to distinguish autonomous (or isolated) solar water heating installations and combined ones, combined with traditional sources of thermal energy. According to their purpose, they are divided into DHW installations, heating installations, air conditioners and various combinations of the latter.

Solar collectors. The main element of a solar installation is a solar collector, which is used to capture solar energy and convert it into the heat of water, air or some other heat carrier. There are two types of solar collectors - flat and focusing.

Flat collectors are usually used in low temperature installations. Their work is based on the so-called hot box principle. The solar collector has a flat radiation-absorbing surface that has reliable thermal contact with the rows of pipes or channels through which the coolant moves. All this, taken together, forms a single structural element called an absorber. It is made of materials with high thermal conductivity: steel, aluminum, copper, etc. For better absorption of solar energy, a special absorbing coating is applied to the outer surface of the absorber or the surface is painted black. The coolant temperature in a flat collector is usually 60 - 90 °C and rarely exceeds 100 °C. An important advantage of a flat collector is that it captures both direct (radiant) solar energy and scattered energy. Therefore, the collector can be installed permanently, without a sun tracking device. Flat collectors are made up of separate sections with an area of 0.6 - 5.0 m2 and are placed on the roofs of buildings, structures or near the ground.

Focusing solar collectors consist of a system of mirrors and lenses. This type of collector must be equipped with an automatic sun tracking system. Such systems allow obtaining a high density of solar energy, therefore they are used where high temperatures are required: in solar power plants, ovens, etc. In heating systems, focusing collectors are usually not used. The mirrors of the focusing collectors (flat, paraboloid or paraboloid-cylindrical) are made of highly reflective metal sheets or foil, and the lenses are made of glass or plastics.

Heat accumulators. The need to accumulate heat in solar heating systems is due to the inconstancy of the value of solar radiation. The simplest accumulator is a storage tank as, more complex heat accumulators are also used in more powerful installations. By the nature of the physicochemical processes occurring in heat-accumulating materials, batteries are distinguished:

capacitive type, in which the heat capacity of the material is used (water, stone, aqueous solutions of salts, etc.);

phase transition, in which the heat of fusion or solidification of a substance is used;

energies of reversible chemical and photochemical reactions.

Solar power plants

There are a number of methods for converting solar energy into electricity, which are based on various processes: thermodynamic, thermionic, thermoelectric, photovoltaic, photovoltaic, photoemission. However, so far the practical only two of them are used:

thermodynamic, based on the use of well-known thermodynamic cycles of heat engines;

photovoltaic, based on direct conversion of light and infrared radiation into electricity by semiconductor photocells.

Conclusion

Thermodynamic solar power plants. With the help of a curved solar collector, consisting of a large number of mirrors (heliostats), solar energy is focused in a small volume, where a heat sink is located, the coolant in which is water, air or other gases. As a result, respectively, either saturated steam with a temperature of up to 550 °C, or a gas with a temperature of up to 1000 °C is obtained. Then one of the traditional thermodynamic cycles (Rankine or Brayton) is realized. The biggest challenge is solar collector control. Heliostats are supposed to track the movement of the Sun while rotating around two axes. The smallest deformation of the collector, associated, for example, with uneven thermal expansion of its structural elements, leads to a violation of focus and a decrease in the overall efficiency of the collector. As a result, the tracking system turns out to be very complex, and

its control is carried out with the help of a computer. Therefore, in particular, the production of saturated steam is limited, since the allocation of a separate superheater will further complicate the management of the collector.

Photovoltaic power plants. Semiconductor devices that allow converting solar radiation directly into electric current are called photovoltaic converters (PEC), or solar batteries. The photoelectric effect occurs when certain semiconductor materials are illuminated with visible and near infrared light. In this case, photons are absorbed, and their energy is converted into electrical energy by means of p - n - compounds. This effect has been known for a long time and is widely used in measuring instruments, automation equipment, etc. Since the beginning of space exploration, the photoelectric effect has been used to power artificial space objects. This is how photovoltaic power plants (PVPs) appeared - practically the only sources of electricity at space stations. Nowadays PVPs have no alternative in space energy. Cells based on semiconductor silicon with a thickness of 50 microns have a low weight, high reliability, practically unlimited service life. The modular design principle makes it possible to create PVSs of any power from them, and such PVs are simple in design, do not have any rotating parts, and do not require special maintenance.

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